Stream Salamander Species Richness and Abundance in Relation to Environmental Factors in Shenandoah National Park, Virginia

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Abstract

Stream salamanders are sensitive to acid-mine drainage and may be sensitive to low acid-neutralizing capacity (ANC) of stream water and soils in watersheds. Many streams in Shenandoah National Park (SNP), Virginia, experience episodic acidification from acidic precipitation inputs, and studies have indicated effects on stream biological communities. We surveyed for salamanders at 49 stream sites using 25-m by 2-m transects on stream banks adjacent to water channels in SNP using a stratified random sampling design. The sampling design was based on elevation, aspect, and bedrock geology and was focused on three species: northern two-lined salamander (*Eurycea bislineata),* northern dusky salamander (*Desmognathus fuscus),* and seal salamander (*D. monticola).* We investigated the relations among salamander metrics (number of individuals, number of species, count of *E. bislineata*, summed count of *D. fuscus* and *D. monticola*, total body length, snout-vent length), habitat variables (elevation, aspect, number of crayfish, number of overturned rocks) and water-quality parameters (temperature, pH, specific conductance, ANC concentration).

We did not find overwhelming evidence that stream salamanders are affected by the acid-base status of streams in SNP. *D. fuscus* and *D. monticola* abundance was greater in streams that had a higher potential to neutralize acidification and in higher elevation (>700 m) streams. Neither abundance of *E. bislineata* nor species richness were related to any of the habitat variables. Our sampling method preferentially detected the adult age class of the study species and did not allow us to estimate population sizes. Laboratory studies and additional field monitoring are needed to determine the effects of watershed acidification on stream salamander populations.

Methods

- Surveyed 49 stream sites (fig. 1) from 6/3/99 through 7/12/99
- Sites selected by stratified random design based on elevation, underlying bedrock, and aspect
- Sites located at least 500 m apart along stream channel
- 25 sites at ≤ 700 m (low) and 24 sites at > 700 m (high)
- 1/3 of sites on each of bedrock types: basaltic (16), granitic (17), siliciclastic (16)
- ~1/4 of sites on north (12), south (14), east (12), west (11) aspects
- Stream order: headwater seeps (5), first (33), second plus third (11), representative of stream order distribution in the Park
- Used area-constrained, visual encounter streamside transects (25 m x 2 m)
- Salamanders captured by hand and with dipnets
- Recorded species, age class, snout-vent length, total length, size of cover object
- Counts of northern dusky (*D. fuscus*) and seal salamanders (*D. monticola*) were combined into the variable DESMOG
- ANC estimated using relations between H^+ and ANC from data collected from streams throughout SNP on the three bedrock types
- Salamander metrics were analyzed using Spearman rank correlations, ANOVA, and nonparametric Kruskal-Wallis tests

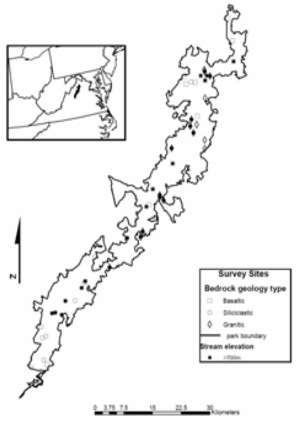

Figure 1. Locations of survey sites

Desmognathus fuscus with eggs at Hawksbill Creek

Results

- Captured and measured 459 salamanders, including 362 adults and 97 larvae (Table 1)
- Found an additional 378 salamanders but did not capture them
- The number of streams out of 49 in which species were found:
  - *Desmognathus monticola*, 40
  - *D. fuscus*, 41
  - *Eurycea bislineata*, 43
  - *Gyrinophilus porphyriticus*, 33
- Number of DESMOG and total number of salamanders were positively correlated with the number of rocks overturned in the transects (ROCKS)
- Number of DESMOG was significantly related to ANC class including the covariate ROCKS
- Number of DESMOG was weakly ($r^2 = 0.17$), but significantly ($P < 0.01$) related to stream pH (fig. 2)
- Few significant associations between salamander metrics and stratification variables
- *E. bislineata* larvae were shorter in total length on siliciclastic and granitic bedrock compared to basaltic bedrock
- Density of rock cover was related to salamander density

TABLE 1.-Captured salamanders at 49 stream sites in Shenandoah National Park showing species, age class, count (n), snout-vent (SVL) and total lengths, and rock areas. Data presented as mean ± standard error.

Species	Age Class	n	SVL (mm)	Total Length (mm)	Rock Area (cm^2)
E. bislineata	Larva	24	21 ± 1.2	37 ± 1.7	357 ± 54.3
	Adult	81	30 ± 0.8	58 ± 1.6	345 ± 40.1
D. fuscus	Larva	37	23 ± 0.8	41 ± 1.6	550 ± 132.5
	Adult	145	43 ± 1.0	76 ± 1.9	596 ± 51.3
D. monticola	Larva	8	22 ± 1.4	41 ± 3.1	526 ± 218.1
	Adult	119	42 ± 1.4	79 ± 2.8	442 ± 41.7
G. porphyriticus	Larva	28	45 ± 2.2	79 ± 2.8	802 ± 151.4
	Adult	17	62 ± 4.2	103 ± 6.4	575 ± 141.4

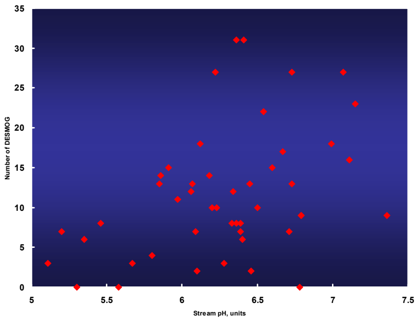

Figure 2. Relation between stream pH and number of DESMOG

Sampling at Ivy Creek

Conclusions

- Because we did not sample the larval age class efficiently, we cannot determine whether the proportion of larval and adult salamanders is different among streams with different acid-base status
- Desmognathine salamander abundance may be affected by stream acid-base status
- Stream salamanders may be particularly affected if episodic acidification occurs during sensitive stages such as egg deposition or larval development
- Further laboratory studies and field monitoring of larvae and adults are needed to determine whether watershed acidification is impacting stream salamander populations
- Monitoring of stream salamander populations in relation to stream acid-base status should continue—especially in federally protected areas of the mid-Atlantic region
- Future research should use estimation techniques (e.g., MacKenzie et al. 2002) to determine population response to habitat change in protected areas

References

MacKenzie, D. I., Nichols, J. D., Lachman, G. B., Droege, S., Royle, J. A., and Langtimm, C. A., 2002, Estimating site occupancy rates when detection probabilities are less than one: Ecology **83**: 2248-2255.